feed. Rats consuming a dietary feed containing 10-percent maltitol had significantly fewer caries than the sucrose group. Details of this study and the results were not given in this reference.

Gehring and Karle (Ref. 62) evaluated the cariogenic properties of isomalt, in comparison to those of sucrose and xylitol in the basal diet of conventional and gnotobiotic (i.e., specially reared laboratory animals in which the microflora are specifically known) rats. The final concentration of sweetener in the feed was 30 percent. A second experiment was performed using isomalt, xylitol, sorbitol, and sucrose in chocolate. The basal diet constituted 40 percent of the total diet, and the chocolate constituted 60 percent. The isomalt group had significantly fewer caries than the sucrose group, and the xylitol group had significantly fewer caries than the isomalt group. The second experiment showed significant differences in caries experience after the T (initial caries lesions) and B (advanced caries) stages between the sucrose and sorbitol chocolate groups, the sorbitol and isomalt chocolate groups, and also between the isomalt and xylitol chocolate group. The order of cariogenicity of the test substances was sucrose greater than (>) sorbitol > isomalt > xylitol > control. An in vitro microbiological experiment was performed to test acid production capacity of plaque microorganisms in 10 percent solutions of isomalt, glucopyranosido mannitol (GPM), glucopyranosido sorbitol (GPS), sorbitol, mannitol, sucrose, and fructose. GPS and GPM are the two components that make up isomalt. Sucrose produced acid rapidly and had the greatest acid formation. Sorbitol and mannitol produced acid slowly, and isomalt and its two components had practically no acid production in vitro.

Karle and Gehring (Ref. 63) evaluated the cariogenicity of isomalt in rats. Six groups of rats received the basic diet without low molecular weight carbohydrates in addition to xylitol, sorbose, isomalt, lactose, and sucrose. The control group received only the basic diet. Sweetener concentrations were increased slowly up to 30 percent by weight of the basic feed. The highest number of fissure caries were caused by sucrose (about 33) followed by lactose (25), isomalt (about 13), sorbose (about 12), xylitol (about 7) and the control (5). Differences in caries incidence between the sucrose and the other groups were significant.

Larje and Larson (Ref. 64) fed rats a caries diet, diet 2000, to which various sweeteners were added. The caries diet, containing 56 percent sucrose, was used as a control ration. Sucrose substitutes used in at least one of the experiments included glucose, fructose, mannitol, sorbitol, potato starch, starch/sucrose mixtures, or HPS (contains sorbitol and hydrogenated dextrins). In the first experiment each group was fed diet 2000 for a few days, then they were changed to one of the diets containing a sucrose substitute. Each test diet was fed for 7 out of every 14 days followed by rotation back to the control diet. The diets were changed every 2 or 3 days according to a predetermined schedule. A second experiment was designed to determine the effect of feeding the sucrose diet after the period of bacterial implantation on diets containing sucrose substitutes. The animals consumed one of the test diets the first week while being inoculated with *S. mutans,* followed in the final 7 wk by the control diet containing sucrose. A third experiment was designed to determine the effect of feeding sucrose and sucrose-substitute diets intermittently after the period of bacterial implantation on the sucrose diet. The animals consumed diet 2000 the first wk, followed in the final 7 wk by diets containing the sugar substitutes.

The results of the first experiment showed significantly ($p<0.001$) fewer smooth surface caries with all sugar alcohols, potato starch, dextrose, and hydrogenated starch compared to the sucrose group. Significantly ($p<0.05$) fewer sulcal caries were experienced in the groups receiving mannitol, sorbitol plus starch, potato starch, and HPS compared to the sucrose group. The authors observed that in all of the experiments, every group in which sucrose was restricted, whether by dietary substitution or by shortened feeding periods, developed significantly fewer caries on smooth surfaces compared to the sucrose control animals. The animals in the mannitol, sorbitol plus starch, and sorbitol groups consumed less food during the test period compared to the sucrose controls. The authors stated that food consumption and weight gains were directly related to the incidence of caries.

The results of experiment 2 showed significantly ($p<0.001$) fewer smooth surface caries in groups fed hydrogenated starch, potato starch, dextrose, fructose, sorbitol plus starch, dextrose plus fructose compared to the sucrose group. Groups receiving HPS, fructose, and sorbitol plus starch experienced significantly ($p<0.001$) fewer sulcal caries compared to the sucrose group.

The results of experiment 3 showed significantly ($p<0.001$) fewer smooth surface caries in groups receiving potato starch, fructose, sorbitol plus starch, dextrose plus fructose, dextrose, and hydrogenated starch compared to the sucrose group. The overall results showed that reducing the exposure to sucrose results in fewer carious lesions.

Mühlemann (Ref. 65) tested the effects of topical applications of sugar substitutes on caries incidence and bacterial agglomerate formation in rats receiving a cariogenic diet containing 20-percent sucrose. Sweeteners tested (50 percent w/v) included the following: Sucrose, mannitol, GPS, GPM, isomalt, sorbitol, maltitol, and French HSH. Three control groups were used: (1) One group received the cariogenic diet (20-percent sucrose) and no topical applications, (2) the second group received a topical application of water with the cariogenic diet, and (3) the third group was treated topically with chlorhexidin digluconate (0.5 percent) as a positive control. Topical solutions were applied five times a day for 23 days.

Among the carbohydrates treatments, the isomalt, GPS, and GPM groups had the lowest incidence of fissure and smooth surface caries. The differences, however, between the caries incidence in these three groups and the other test groups were not statistically significant. The incidence of caries in the chlorhexidine control group was statistically significantly lower than all treatment groups. The control groups receiving no application and water both experienced slightly more caries than the sugar alcohol groups. Results of these studies suggest that in the presence of a cariogenic diet, topical application of mannitol, isomalt, sorbitol, maltitol, or HSH does not affect the promotion by sucrose of dental caries in rats.

Ooshima et al. (Ref. 66) evaluated the cariogenicity of maltitol in rats infected with *S. mutans.* Animals were divided into 12 groups. Group A received a control diet containing 56-percent wheat flour. Groups B through L received the same diet as the control group but had portions of the wheat flour replaced with one of the test substances. The sweeteners tested were as follows: 10-percent maltitol plus 46-percent wheat flour (group B), 20-percent maltitol plus 36-percent wheat flour (group C), 10-percent sucrose plus 46-percent wheat flour (group D), 10-percent sucrose plus 10-percent maltitol plus 36-percent wheat flour (group E), 20-percent sucrose plus 36-percent wheat flour (group F), 20-percent sucrose plus 20-percent maltitol plus